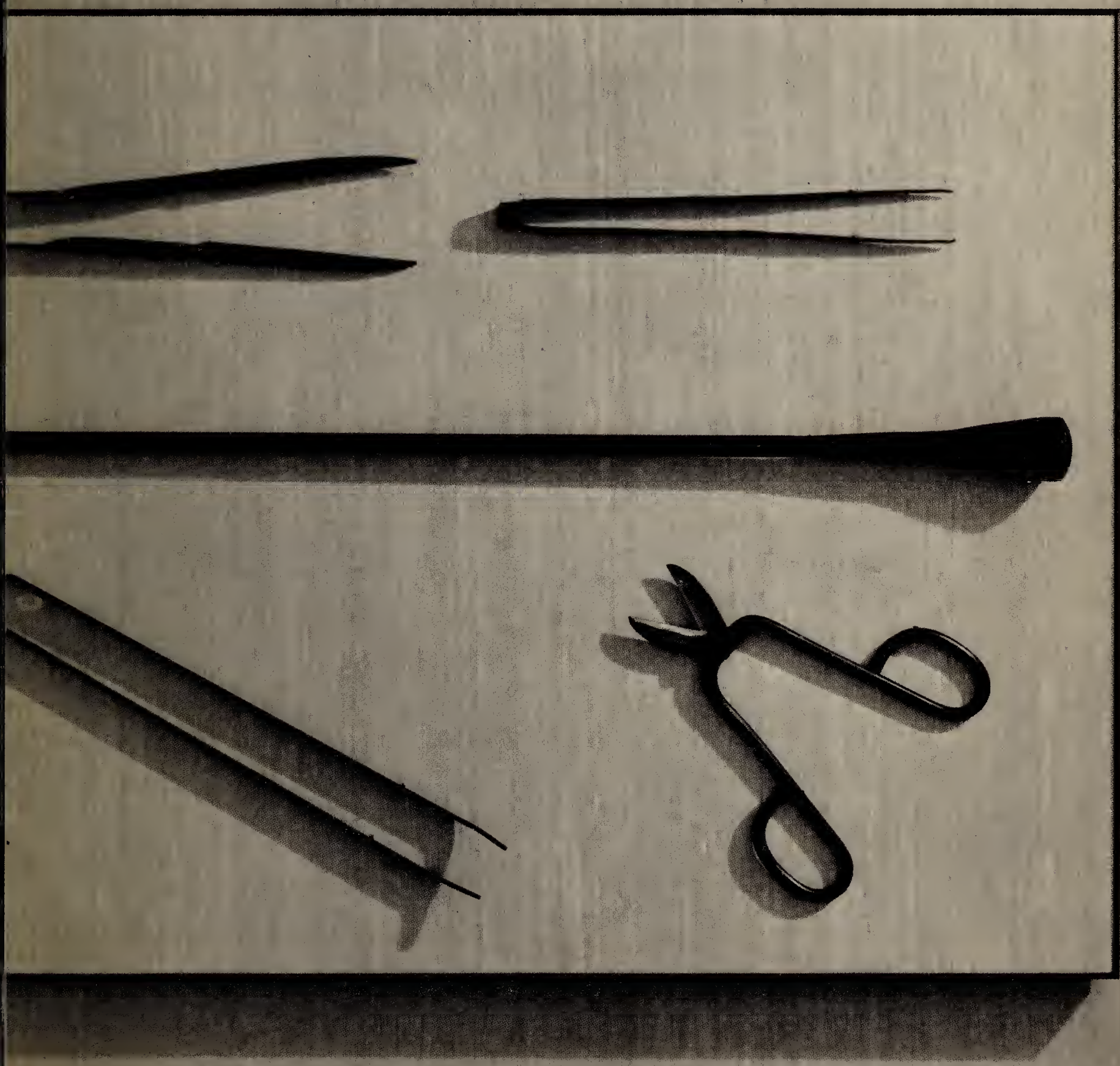
HOW GLASS IS MADE



THE TOLEDO MUSEUM OF ART : MUSEUM NEWS

GLASS AND THE MUSEUM

Brilliant, brittle, fragile, fluid in form, glass has been a rare commodity and highly prized throughout most of history. It is only within the last hundred years when it has been possible to make glass by machine that it has become a common and inexpensive substance. In antiquity it was more rare than gold, and as precious as the finest jewels.

In recent years this Museum has published a series of handbooks on the Museum's glass collection, including Ancient and Near Eastern glass, the European glass collection, American glass, and Modern glass. Most recently the Museum published a guide to the glass collections, *Art in Glass*. These handbooks explored the historic background of glass. This publication is devoted to glass itself as a material and how it is used by the creative artist.

Glass is unique among materials available to artists in that it must be worked at a temperature too hot to handle. Unlike any other artisan, the glassmaker must keep his work at arm's length as he shapes the molten material.

Until recently glass was not considered a suitable material for handcrafting. The heat necessary to melt glassmaking materials was beyond the capacity of the average craftsman, while the difficulty of working a material so different and unfamiliar seemed insurmountable to artists used to working in pottery, stone, wood or textile.

However, ten years ago The Toledo Museum of Art initiated the first seminar in glass craftsmanship in an effort to explore the possibilities of working in this challenging and somewhat recalcitrant material.

It was found through this pioneer seminar and succeeding workshops that a new movement of glass craftsmanship could be developed. Today, after only ten years, glass craftsmanship is being taught in colleges across the country. The Toledo Museum, with funds provided by Toledo's glass industry, has built a studio for the express purpose of teaching glassblowing and forming, and has presented biennial exhibitions of the developing work of the glass craftsmen, circulated nationally by the Smithsonian Institution.

This publication illustrates how glass is made by hand and describes Toledo's pioneering involvement in the new glass-crafts movement.

Otto Wittmann, Director

Cover: Glass making tools.
Tools used in making glass by hand have not changed in many centuries. These tools were used by the Libbey Glass Co. about 1900 and were given to the Museum by Dominick Labino.

Museum News
The Toledo Museum of Art
Toledo, Ohio

New Series:
Volume 15, Number 1

WHAT IS GLASS?

Glass can be described as an inorganic product of fusion which has cooled to a rigid condition without crystalizing. It is among the few apparently solid materials that have little or no crystalline structure. It has therefore been called a supercooled liquid: a substance that has passed from a liquid into a rigid state without developing a structural pattern. Glass is typically hard and brittle and has a conchoidal or shell-like appearance when fractured.

There are many glass compositions but silica (sand), soda and lime are the three basic compounds that when heated together at temperatures in excess of 2500 degrees form the fluid material known as glass. Silica is the basic glass-forming oxide. It is difficult to melt and therefore, soda ash (sodium carbonate) is added as a flux to lower the fusion temperature and viscosity or resistance to liquid flow. Lime (calcium oxide) is also added as a stabilizer.

Silica is the only glass-forming oxide which will produce a stable glass and since most of the earth's surface is silica, glass making has been wide spread. Glass exists naturally as the volcanic substance, obsidian.

The discovery of glass as a man-made substance is lost in history. Knowing that a temperature of over 2500 degrees is necessary for fusion of the basic raw materials, it is difficult to imagine this discovery being made accidentally.

It has been suggested that a potter might have discovered beads of glass as a result of over-firing the glazes on his pottery. Glass beads were in existence before glass vessels. This assumption seems to have more validity than the popular myth, as related by Pliny in his *Natural History,* that glass was first discovered accidentally by Phoenican merchants who, while building a camp fire on the shores of the Mediterranean, caused sand to be fused by heat by using natron blocks around a fire on a sandy beach. No camp fire would be hot enough to fuse silica with the unheated natron which was an impure form of soda ash.

Color in glass is produced by several means: colored silicates or other colored salts dissolved in the glass, a colored colloidal solution, a suspension of undissolved particles of appreciable size, a solidified emulsion, or by devitrification. Basic glass composition may therefore result in color, but oxidation and reduction may also affect color. Green can be made from chromium oxide, purple from manganese, amber from carbon-sulfur-iron, blue from cobalt oxide, and yellow from uranium. These metallic oxides in combination with other ingredients create color.

Opaque glass is made by adding fluorides which crystallize, some upon cooling and some upon reheating.

Glass therefore is a unique substance, clear or colored, which in its liquid state performs as a liquid—eventually to retain the character of a solid. This has been the fascination of glass over the centuries.

This publication explains how glass is formed by the traditional hand method—a tradition of more than 4000 years, now revived and practiced by a small number of artist-craftsmen. Most of the photographs were taken in the Toledo Museum's Glass-Crafts Building where this handcrafting is taught and may be observed.

Charles F. Gunther

Raw glass, with which the craftsman works, is a fusion of sand, soda and lime.

THE TOOLS OF GLASS

The craftsman's work bench.

The glass craftsman requires only basic simple equipment. He must have a source of molten glass, the equipment to form it into the desired shape and the means to cool the glass without breakage.

FURNACES

It is assumed from archeological discoveries that ancient glass was melted in small individual refractory containers or clay pots. These were used mainly for small melts to provide the craftsman with special colors or compositions. Crucibles or pots are still used today. Where larger amounts of glass are required, furnaces are constructed in which the glass is melted in the bottom of the furnace itself. A day tank furnace melts glass at night for operation during the day. The size of such a furnace depends upon production needs. A small tank furnace is constructed of rectangular refractory brick bound together with metal tie rods.

TOOLS

The glassmakers tools have not substantially changed for many centuries. The *blowpipe* or blowing iron comes in all sizes and depends a great deal upon the size of the object to be produced. The blowpipe is a hollow metal tube usually heavier and flaring at the gathering-end.

The *pontil rod* or punty is a solid metal rod. Glass objects are usually transferred from the blowpipe to the punty for support during the finishing process. The punty is usually thinner than the blowpipe ranging from between ⅜″ to ½″ in diameter. It is usually the same length as the blowpipe and is also used to apply small gathers of glass to the exterior of a piece. In preparation for forming the glass, the blowpipe and pontil rods are preheated by resting on the yoke which stands to the side of the furnace opening. When these tools are preheated the viscous glass will adhere more easily.

The glass craftsman also uses a variety of wooden forming *blocks* cut from dense close-grained fruitwood such as apple or cherry. These blocks are kept soaked in water to prevent burning. *Paddles* are also made of pieces of hardwood and are often used either wet or dry to shape the outer surfaces or center a piece.

As glass is too hot to touch, metal *tweezers* are used to pinch and pull. *Shears* are used for trimming and cutting. Trimming shears look like tin snips. Cutting shears have square openings with thin shearing edges. *Jacks* consist of two long wooden or steel fingers, connected by a long spring loop. They may look something like tweezers but they are used to indent or constrict a form or pull it out in the forming process.

BENCHES

The glassblowers bench or chair provides two arms extended forward to support the blowpipe as it is rolled back and forth. The bench extends beyond the arms on one side to provide room for tools. All tools should be within immediate reach. A shield is customarily attached on the working side to protect the craftsman's legs from heat.

ANNEALING OVENS

To remove internal stress in glass it must be cooled gradually. The annealing oven is used for this purpose. The completed glass object is placed in the heated chamber where it remains until strains which would result from uneven cooling have been removed. Annealing is a carefully controlled gradual cooling process which depends upon the use of a pyrometer to indicate the temperature inside the kiln or lehr and automatic timing devices to regulate the reduction in temperatures. Once cooled, the rough pontil marks may be removed by grinding and polishing.

HAND-FORMING OF GLASS

1. The initial gather

2. Gather removed from furnace

The use of a blowpipe to blow glass is an ancient technique discovered just before the birth of Christ. However, the art of hand blown glass had all but disappeared in America until the revival of the art began ten years ago at a seminar at The Toledo Museum of Art. Following the steps in the creation of a simple bowl will demonstrate the basic procedures necessary for the hand forming of a glass object.

The blowing pipe and punty have been placed on a yoke resting near the furnace entrance. When the metal pipe is hot the molten glass will adhere easily. For the initial gather the blowpipe is rotated as it touches the molten glass in the furnace. The temperature of the furnace is now about 2000 degrees. It requires experience to work in front of the glass furnace. Dark glasses protect the craftsman's eyes from the flame. Clothing should protect the arms and legs from any chipping of glass. The glass itself flows very much like taffy. The initial gather will not be enough for the final bowl and more than one gather will eventually be required.

3. Gather being shaped

4. Formation of parison

5. Initial bubble

After removal from the furnace the blowpipe is slowly rotated to keep the glass centered on the tip of the pipe. The initial gather is shaped by rolling back and forth on the marvering table (coming from marble). On this flat marble surface the shaping is accomplished by lowering and raising the blowpipe during the rolling process. The glass surface becomes more rigid when rolled over the cool marble surface. This gives the artist more control during the initial enlarging. The initial glass shape is called the parison. The forming of the parison will be critical for the final completion of the glass bowl. At this point the flow of the hot glass must be carefully controlled through reheating.

6. *Blocking of glass form*

7. *Reheating*

8. *Blocking of enlarged form*

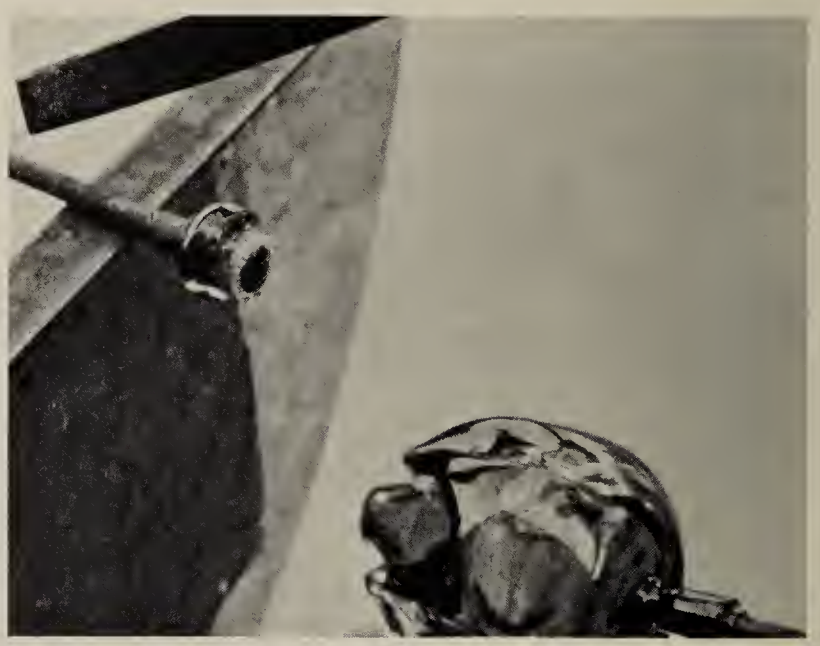
With the expansion of the parison a wooden block is used for shaping. These wooden cup-shaped blocks are made to accommodate a variety of forms. The block not only helps to create the form desired but also chills the skin of the glass form to give resistance for further blowing. The blowpipe must then be returned to the furnace or to a glory hole for reheating. Following each reheating the bubble will be expanded and the blocking will continue. If a larger piece is to be made the bubble must be returned to the furnace for a third gather. Having achieved the desired size and thickness of the wall, the craftsman pulls the glass with a file to create a decorative pattern and to give the bowl more thickness along the lip. He places four of these decorative forms symmetrically around the bowl.

9. *Pulling glass form*

10. Centering glass form

11. Attaching pontil rod

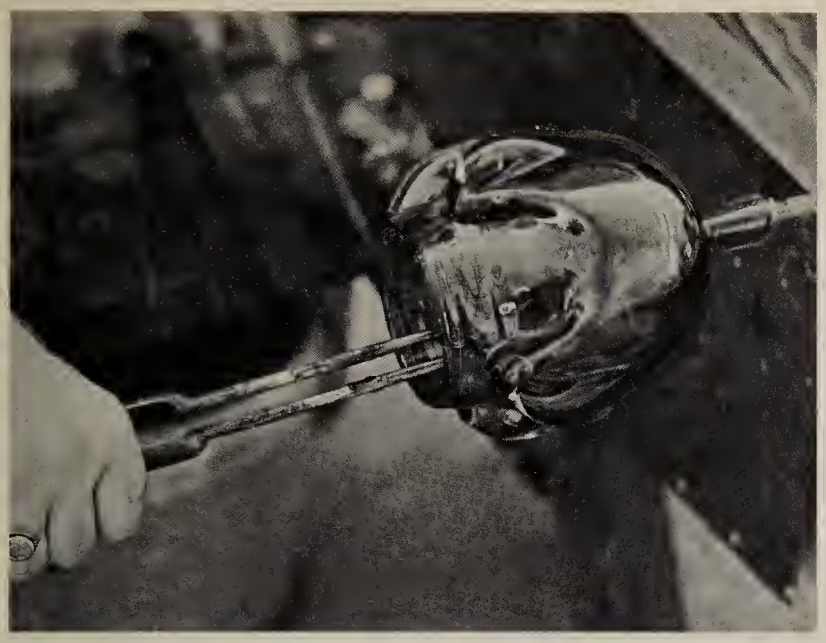
12. Filing blowpipe



13. "Crack Off," transfer to pontil rod

14. Reheating in glory hole

Now that the basic glass form has been created the craftsman uses a wooden paddle to center the shape as exactly as possible. The glass is cooled sufficiently to have some resistance to flow. A small glob of glass is collected on the pontil rod and it is marvered to a symmetrical form. Using a file to steady the end of the punty, the glob of glass is attached to the base of the blown form. Once the punty has been securely attached to the blown form, a metal file dipped in water is dragged across the neck of the blowpipe. The chill of the water is sufficient to break the glass from the blowpipe. A sharp rap with the file will "crack off" the blown piece. The piece must now be returned to the glory hole for reheating.



15. Enlarging of bowl

16. Further enlarging of bowl

17. Bowl completely open

18. Cracking off bowl from punty

After reheating the bowl the craftsman begins to form and enlarge the lip of the bowl using metal and wood jacks. By rotating and spinning the bowl, the pressure applied on the inner rim allows the form to expand. As the bowl cools and becomes more resistant to such pressure, it will have to be returned to the glory hole for reheating. When the bowl has been enlarged to its full form, it is removed from the pontil rod with the sharp crack of a metal tool. It is still too hot to handle and so the craftsman uses asbestos gloves to place the glass in the annealing oven. The bowl has taken 45 minutes to form and will remain in the annealing oven over night to cool slowly.

19. Bowl placed in annealing oven

TOLEDO'S GLASS COLLECTIONS

The world-famous glass collections of the Toledo Museum of Art are among the largest and finest in existence. It is appropriate that they should be, for Toledo's economy is founded on glass.

Edward Drummond Libbey brought his glass company from Cambridge, Massachusetts, to Toledo in 1888. The glass industry prospered and became the city's major industry. Mr. Libbey and a group of his associates founded The Toledo Museum of Art in 1901. In 1913, a year after the Museum's building was dedicated, Mr. Libbey began to acquire glass. From the collection of Julius Campe of Hamburg, Germany he acquired 80 pieces of European glass. Four years later Mr. Libbey bought and presented to the Museum more than 450 items of all periods from the Philadelphia collector, Edwin A. Barber. The largest single acquisition of glass was the gift of Mr. and Mrs. Libbey in 1923 of the greater part of the collection of Thomas E. H. Curtis of Plainfield, New Jersey. This collection, numbering in the thousands, consisted of ancient and Islamic glass and was probably the largest private collection of ancient glass ever formed. In 1950 the Museum acquired with Libbey funds nearly 50 pieces consisting mainly of rare German engraved and enamelled glass from the noted collection of Frederic Neuburg of Leitmeritz, Czechoslovakia, providing a balance to the Campe Collection which was predominantly Italian. The American collections were enriched in 1959 by the addition of 55 early pieces from the collection of George McKearin of Hoosick Falls, New York. The 1960's brought to the Museum the finest known collection of American pressed glass, the gift of Mrs. Harold G. Duckworth of Springfield, Massachusetts. In addition Owens-Illinois, Inc. presented a large number of New England Glass Company and Libbey wares which together with previous gifts in 1951 totals some 250 pieces. Certainly Toledo's glass collection is a collection of collections.

The new Art in Glass Gallery, the gift of Mr. and Mrs. Harold Boeschenstein in 1970, has been described as a museum within a museum. It contains pieces of glass from all periods, arranged in chronological sequence. At the entrance to the gallery is a glass mural designed and created by Dominick Labino, the Museum's Honorary Curator of Glass. The mural is the gift of Mr. and Mrs. Labino and conveys the spirit of glass as a flowing media frozen in space.

Almost 2,000 pieces in Toledo's glass gallery illustrate glass making over 4,000 years of history.

A marble-walled ramp connects two floors of the glass gallery.

VITRANA: A GLASS MURAL

When the Museum's glass gallery was planned it seemed appropriate to the Museum's director, Otto Wittmann, to include a glass mural at the entrance. Dominick Labino was invited to design and execute the work which occupies the nine-feet square wall space.

As no such mural had previously been attempted, Dominick Labino began in early 1969 at his studio in Grand Rapids, Ohio to work with hot glass on a pontil iron, tooling and whirling it into various abstract forms of comparatively flat glass in varying colors. These were mounted in a metal framework designed so the shape of the surrounding metal conformed to the different shapes of the glass. The mounting of these free-form shapes presented a problem, since the amount of metal overbalanced the glass. Mr. Labino then turned to a new process of hot-cast rectangular panels. The casting was done while the glass was in a molten form, and the designs within were achieved by freehand molten inlay at the time of hot-casting. Mr. Labino described some of the problems he faced,

"A special annealing oven had to be developed, as well as methods of handling the hot glass. Critical problems in annealing had to be solved, since many of the panels consisted of a combination of different glasses to achieve design and color variation. These glasses had to have the same coefficient of expansion. And, several factors influence the setting rate in relation to time:

1. The rate of viscosity change as related to temperature.
2. Temperature of the glass at the beginning of the cooling period.
3. The color of the glass.
4. Certain physical properties of the mold material which is in contact with the glass.

Many unusual colors and color effects were achieved by prolonged controlled cooling. These compositions were sensitive to time and temperature relationships. Many of the panels required two days to anneal successfully."

The panels were rectangular in shape, with some slight variation in thickness from panel to panel. The outer edges were kept in their natural state, since the plan was to mount them without encasing the edges in any way. A light steel frame was devised so that the panels could be held in place by metal pins bolted to the frame. Thus, the panels would appear to be floating in space, and the entire mural would be a play of color, light and design in glass.

First step in the development of the Labino mural: a flat irregular blown bubble. Later panels were hot-cast into rectangular shapes.

Labino has said, "As each new panel was taken from the annealing oven, the experience of viewing and selecting became each day more exciting. My son-in-law, John Black, built a wooden easel to mount the panels for temporary placement. The mural gradually took form. My friend, Otto Wittmann, with whom I consulted regularly on these developments, made regular and frequent visits giving advice and many helpful suggestions."

On September 11, 1969, the steel frame which had been hand-built at the studio by the artist and his son-in-law was erected in the glass gallery entrance. The next day the two men installed the thirty-three glass panels using 132 metal pins, each of which they had specifically ground, shaped, and machined to fit an exact spot on a given panel. The meticulous work of installation was finally completed towards midnight.

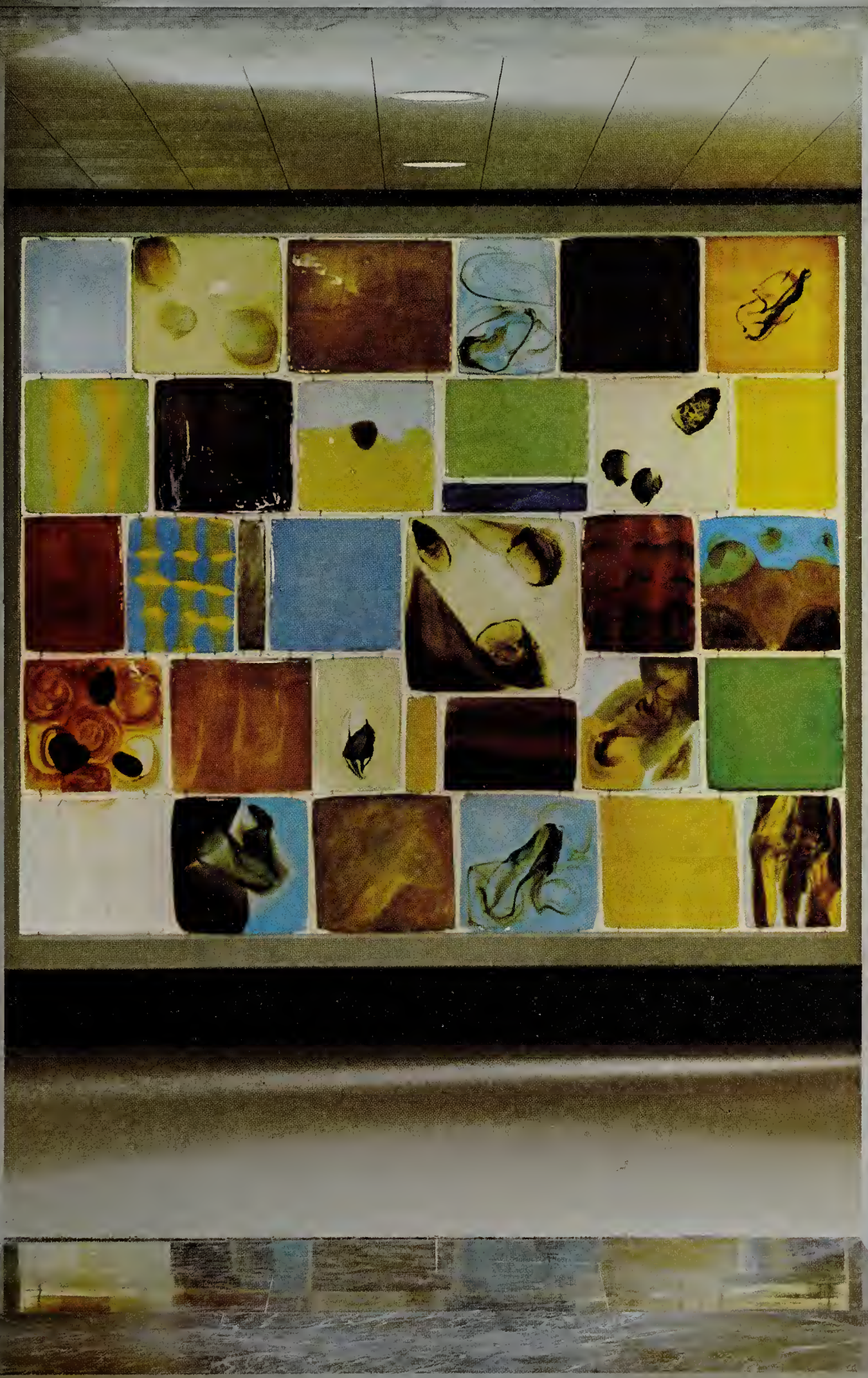
Dominick Labino, the Museum's Honorary Curator of Glass, continues to develop new techniques.

The light source for the mural is a series of concealed incandescent lights which evenly and indirectly transmit light through the subtle colors and design of the mural's panels.

The artist's wife who collaborated closely on the mural's design, has explained the name Vitrana. "A name for the mural evolved by coining a word with the Latin base *vitrum* (glass) and adding a suffix with a flowing sound to harmonize with the hot flow of glass. Thus, *vitr-* plus a-*n*-a, Vitrana. And so the colors flow, and the panels float in space, so that the viewer can either revel in the play of light and color, or pause and reflect on a particular panel for its own color and design."

At right:
Vitrana, Labino's glass mural (96 x 108 inches), the gift of Mr. and Mrs. Dominick Labino, 1969, stands at the entrance of the Museum's glass gallery.

GLASS THROUGH THE AGES



DECORATING GLASS

Egyptian Sand-Core vessels,
18th dynasty, about 1350 B.C.

Egyptian sand-core glass vessels of the 18th dynasty (1567-1320 B.C.) were small and designed mostly as perfume and ointment containers. They were precious in their own time and required patience and a high level of craftsmanship. There are many theories regarding the method the Egyptians used. Mr. Dominick Labino, the Museum's Honorary Curator of Glass, has experimented extensively with core vessels. The most plausible method involves dripping or trailing hot glass on a friable sand-based shape. The core may not actually have been made of sand but probably was a loosely fired earthen material. A metal rod inserted into the sand-core would allow it to be rotated and manipulated freely. The hot surface of the sand-core was gradually covered by trailing the molten glass as the core rotated. The threads were then reheated and smoothed creating an even surface. In the process additional glass of various color could also be trailed in thread-like patterns across the surface. Combing the threads with a sharp instrument could produce a variety of patterns. Small handles, lips, and bases would then be applied. After the glass had been completely cooled, in an annealing chamber, the sand-core could be scraped away. This explains the smooth outer surface and the residues of sand still found on the inner surface.

These early vessels show little transparency. Blue opaque colors were favored in imitation of precious stones such as lapis lazuli and turquoise.

Trailing glass is a decorative technique which is unique to glass and has continued through the ages.

THREADING

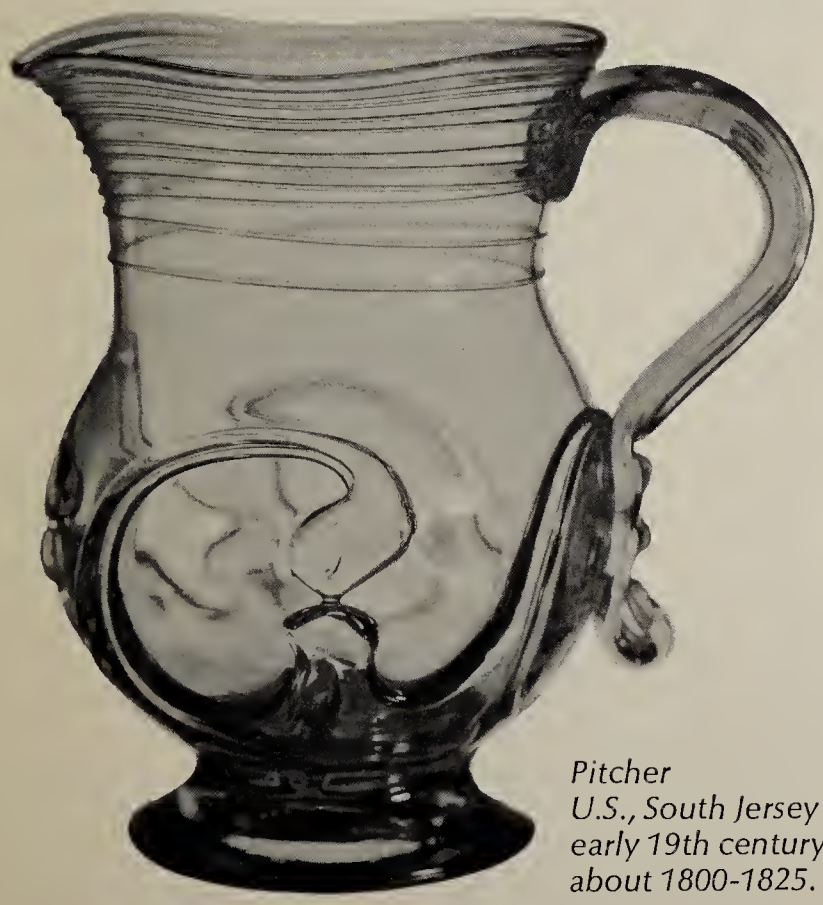
A balsamarium was an unguent flask and was often used by Roman women to hold cosmetics. The basic container shape of lightweight, generally yellow or green glass was free blown with an over-decoration of applied loops, encircling threads and a series of tiered handles. These hot tooled ornaments underscore the basic tendency of glass to drip and form threads. Sometimes a blown cylindrical form was pressed together from top to bottom to form two chambers. The overall threading and the ornateness of the handles possess a certain playfulness.

Applied glass decoration appeared very early in American glass. The basic shape was free-blown. The circular bands of threading on the neck of the bowl have been trailed and the handle applied. The superimposed decoration in swirling effects was so named because of its resemblance to the water lily stem and pad. An additional gather of glass on the lower end of the parison was pulled upward forming the lilypad design.

The use of ancient techniques is again apparent in this simple glass pitcher decorated with rich looping patterns. Bands of opaque color have been trailed on the initial clear glass bubble and pulled or combed in the same manner as the Egyptians. As the vessel is blown and expands, the looping becomes enlarged.

Double Balsamarium
Syrian
3-4th century A.D.

Pitcher
U.S., New Jersey
about 1820.



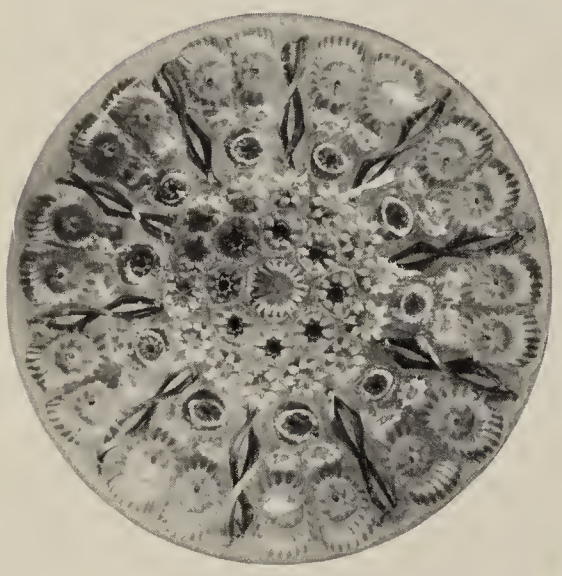
Pitcher
U.S., South Jersey
early 19th century
about 1800-1825.

GLASS CANES

Millefiori bowl, Alexandria or Italy
3rd—2nd century, B.C.

Fused mosaic glass
Egyptian first century B.C.—4th century A.D.

Fused mosaic glass made by the Egyptians was created in various ways. One method involved placing multicolored long glass threads called canes side by side forming a pattern. This bundle of glass threads would then be fused into a larger cane which would be sliced into smaller discs. The cane could be hot-drawn to a much smaller dimension by pulling the cane while hot. They could be used as beads or decoratively on a slab or fused in a mold to produce *Millefiori* (thousand flowers) bowls. The decorative richness results from the repetition of the cane pattern. The bowls could be ground with a lathe to produce an even surface.



Paperweight, Crieff
Perthshire, Scotland
about 1970.

Glass paperweights became popular in the mid-19th century. Glass beads, rods and canes could all be used. The millefiori technique of the Egyptians has been widely used in the production of paperweights. Millefiori patterns were created through the use of glass threads fused together into canes. They were then cut into smaller pieces and arranged in a pattern for the center of a paperweight. These were fused together and then dipped into clear glass repeatedly, marvered and blocked into the shape desired.

Latticinio vase
Venetian
about 1600.

The Venetians were masters of the glass craft and experimented with many decorative effects. Latticinio lace glass is a milk (lattimo) white opaque glass worked into threads with lace like patterns. As with earlier glass, the Venetians used glass canes arranged in a mold in a complex pattern and heated. The glassblower then placed a gather of clear glass formed on his blowpipe into the mold where it was blown until it fused with the glass canes. It could then be removed from the mold and with further reheating would completely fuse the cane into the surface of the glass. The glass was then dipped once more into clear glass encasing the pattern and the vessel could be blown and expanded, enlarging the already complex thread pattern.

GLASS FROM A MOLD

Mold-blown vessel
Syrian, 4-5th century, A.D.

The use of a hollow pipe to force air into a gather of glass may well have been an accidental discovery and may have taken place in Syria shortly before the birth of Christ. The use of the blowpipe permitted much larger shapes to be created. This meant vessels for many occasions and purposes. Glass created on a blowpipe could also be hotter than hand manipulated glass. This produced a glass which was more transparent and clearer. Blowing glass into a mold made it possible to produce quantities of similar glass. Clay molds had been used much earlier for hand formation of glass. Metal molds could be carved with images such as the Christian and Jewish symbols.

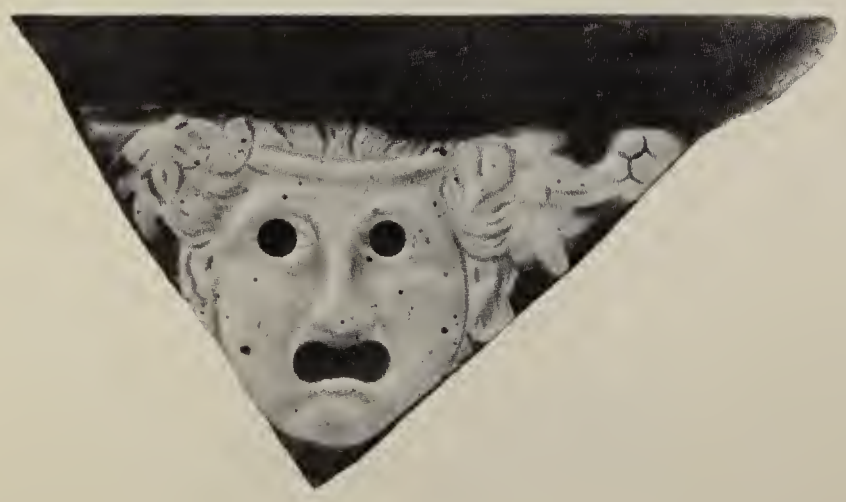
The techniques of pressing glass between a mold and a plunger was developed in America as a mass production technique. It was quicker to produce than blown glass and it had the appearance of more expensive cut glass. Pressed glass differs from mold blown glass in that glass is not on the blowpipe but is dropped into the molded form and then pressed mechanically with a plunger.

Compote, Pressed
The Central Glass Co., Wheeling, W. Va.
about 1870-1880.

SURFACE DECORATION

Islamic Sweetmeat jar and cover
Egyptian or Syrian,
Mameluk dynasty (1250-1517).

Cameo glass, Roman
1st century B.C.—3rd A.D.



The Islamic glass craftsmen were not only skilled in their ability to blow beautiful shapes, they also developed great skills in surface decoration. The enamelled or gilded surface decoration was applied with a brush on the completed vessel. Enamel is a substance containing finely ground bits of colored glass mixed with a binder, usually oil or water, and flux, a material which assists fusion. The second heating fused the enamel to the surface as the flux melted, dissolving the colored binder. This required great skill to preserve the original shape of the vessel, while subjecting it to enough heat to fuse the enamel.

Cameo cutting seems to have originated in Alexandria although it was practiced in Italy as well. Usually precious stones were used for cameo, but it is evident that glass was also considered rare and precious enough for the cameo cutter's art. The problems of blowing two layers of contrasting color were such that the production of cameo glass was very limited. A gather of glass partially inflated is opened into a cup-like shell which is placed in a metal shell. Then a second gather of glass of contrasting color is blown into the mold and the two layers fuse together after reheating. The surface layer could then be ground and modeled using the inner layer for contrast.

Roemer vessels, from left to right:

Signed and dated 1661 by the Dutch engraver Carel DuQuesne. German vessel about 1660.

Green glass. Engraved Latin inscription reads, "Always the Same." Signed and dated 1676 by Willem van Heemskerk (Dutch 1613-92) of Leyden. Holland or German, about 1676.

Cylindrical Vase, Edwin Eisch (1927-) German. November 29, 1967.

The roemer was a drinking vessel with a globular bowl, a stout stem and conical foot. The small raspberry prunts applied to the cylindrical stem made the vessel easier to grasp. The bowl is blown and then decorated with copper wheel engraving. The copper wheels do not do the actual cutting. The wheels trace the outline of the cut, while emery powder mixed with oil or with a mixture of oil and kerosene is fed onto the surface of the wheel as the agent for biting into the glass surface. The first cuts are made by using coarse emery powder. These are then modeled using finer powder to finish the cutting.

Fumed iridescence is created by coating the surface of the cylindrical vase with a thin spray of tin chloride which gives a granulated quality created by a slight shrinkage. To fume a piece of glass, metallic chloride such as iron or tin is placed in a shallow pan and small amounts of hot glass are added to create a fine vapor and reheated. The very thin coating refracts the light.

Objects in Space.
Dominick Labino (1910-).
United States.

Peace Now.
Marvin Lipofsky (1938-).
United States.

Column III.
Harvey K. Littleton (1922-).
United States, 1970.

Blue Dr. Zharchov.
Joel Myers (1934-).
United States.

This free blown form loses its glass quality and becomes a study in surface effects. Sand blasting can roughen a surface producing a coarse texture. Copper plating coats the glass with a fine metallic finish. Contrast is created by the juxtaposition of the high luster finish and the 14 small flocked dots.

The capabilities of glass as an artistic medium are still being explored. The tapering column by Harvey K. Littleton is a solid rod cut on both ends. The simplicity of the shaft tends to give it monumentality. The bulbous interpenetrating cup shapes by Joel Phillip Myers have been cemented together. In a sense the final form is a construction of interrelated units each separately blown. The platinum luster coating is internally applied giving a mirror finish.

The air trapped bubbles penetrating the form enhance the reflective nature of the glass and focus all attention inward rather than on the surface. The sculptural effect of the interior movements create a constant sense of motion. The conscious control of air bubbles within a free blown form of glass and the beautiful finished surface demonstrate the artist's knowledge and control of glass.

THE MUSEUM AND THE NEW GLASS CRAFTSMAN

TRADITIONAL GLASS PRODUCTION

For centuries the methods of producing glass changed very little. Production required a team of men working together. One supervised the firing of the furnace and was responsible for the quality of the molten glass. The gatherer would place the preheated blowpipe into the molten glass, collecting some at the end of the blowpipe. He would then pass the pipe to an apprentice who would roll it to an even proportion on a marvering table. He in turn would pass the pipe to the master craftsman, the gaffer, who would begin to expand the glass shapes by blowing into the blowpipe. The gaffer was usually the most experienced craftsman of the group. When the glass object had been completed by the gaffer, another apprentice usually took the piece and placed it in the annealing oven where it would gradually cool. This traditional method of production required the group of men to function as a unit. Usually as many as six men were needed depending upon the complexity of the glass objects being created. So strong was the belief that glass could only be created by a group of individuals working as a group that the emergence of the concept of an individual artist creating in glass came slowly.

TOLEDO GLASS SEMINAR—1962

Many early attempts by artists to use glass as a creative media involved laminating, casting or fusing preformed glass sheets or containers. However, it was not until 1962 that the first formal instruction in glass craftsmanship was offered at The Toledo Museum of Art.

At the suggestion of Harvey Littleton, former instructor in ceramics at the Toledo Museum and then at the University of Wisconsin, and with the encouragement of the Museum's director, Otto Wittmann, the first glass crafts seminar was offered by the Toledo Museum. In the March 1962 seminar, the 6 students, mostly professional instructors in ceramics, began with nothing but an exhaust hood mounted in the Museum's garage. Their first attempts to build a furnace and melt glass from raw materials were unsuccessful. Dominick Labino, at that time vice-president in charge of research at Johns-Manville Corporation who had donated equipment and advice for the construction of the furnace, provided glass marbles made of a formula which would melt at a temperature low enough for the primitive furnace. Workable glass capable of being blown was made for the first time. The concluding day of the March seminar featured an open house for the Toledo community. An added bonus resulted when several of Toledo's retired glass blowers came to inspect the wares of the novice artists. Gaffers such as Harvey Leafgreen and Jim Nelson both became added sources of inspiration. In succeeding workshops and with the establishment of a full-time teaching program in glass, these men as well as others from the community became frequent visitors to the glass studio. They passed on many skills acquired in a lifetime of glassblowing in Toledo industry.

A second glass seminar was held June 1962. A series of four graduate seminars followed, taught by Mr. Labino, and glass instructional programs began to develop across the nation. By January 1968 regular instruction in glassblowing had become part of the Toledo Museum's educational program.

TOLEDO GLASS NATIONALS

In October 1966, The Toledo Museum of Art organized the first competitive exhibition for creative glass craftsmen. The first Toledo Glass National demonstrated that there were many artist craftsmen creating glass in their own studios. The jurors selected 43 artists for exhibition—an impressive number considering that less than 4 years had elapsed since that first seminar held in Toledo. Work came from over 17 states proving that glass as a craft medium had spread widely in a few years. A selection of works from Toledo Glass National was circulated by the Smithsonian Institution to various Museums in the United States.

The success of such a major exhibition of contemporary glass established Toledo Glass National as a bi-annual exhibition. Toledo Glass National II was held October, 1968. The second competitive exhibition included work from 54 artists from 19 states. The exhibition established an even closer relationship between artists using glass as a creative medium and the Toledo Museum of Art.

Toledo Glass National III was held in October and November, 1970, and like the two previous exhibitions was also circulated by the Smithsonian Institution. Toledo Glass National III highlighted the work of Andre Billeci, Dale Chihuly, C. Fritz Dreisbach, Kent Ipson, Dominick Labino, Marvin Lipofsky, Harvey K. Littleton, Richard Marquis and Joel Phillip Myers. This exhibition demonstrated the sophistication of the glass artist. New forms

were being developed and glass was being combined with other materials. The glass presented had a wide range of scale, some pieces became sculptural without utilitarian function and many reflected the current imagery of the contemporary art scene.

Toledo Glass National IV, to be held in December, 1972 marks the 10th anniversary of the Museum's involvement with creative glass craftsmen. It will honor those artists well established in the glass movement as well as younger craftsmen. It will be the first major exhibition of glass to also appear at the Museum of Contemporary Crafts in New York City as well as other American Museums.

THE GLASS CRAFTS BUILDING

In the autumn, 1969 the Museum became the first institution to construct a building and studio specifically designed for the teaching of glassblowing. Financed by Owens-Corning Fiberglas Corporation, Libbey-Owens-Ford Company and Owens-Illinois Inc., the Glass Crafts Building contains facilities for glassblowing, metalsmithing and sculpture. The glass studio contains an exhaust unit with two furnaces. The center of the room is dominated by two four-port reheating furnaces. These glory holes operate at a temperature slightly below that of the furnaces and allow eight students to work simultaneously. Each reheating furnace is surrounded by four gaffer's chairs. On the opposite wall from the furnace there are four annealing kilns. For the safety of students the studio is also equipped with an emergency shower and an automatic ice maker, to lessen the damage of burns.

The studio includes a spectator viewing area which can accommodate as many as 75 persons, viewing public demonstrations which have been presented Sunday afternoons.

The Glass Crafts Building is the center of a student oriented program. Students come from many backgrounds, from the University of Toledo in the joint degree-granting program, from the Toledo area and communities as far away as Detroit, Michigan. Special seminars and workshops will be continued in this new facility as the Museum carries on its program to encourage the new renaissance of glass craftsmanship in America.

The Museum's modern Glass Crafts Building was contributed by Toledo's glass industry in 1969.

Students in glass craftsmanship work at the Museum's glass furnaces.

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Photographs of glass forming by Herral Long

THE TOLEDO MUSEUM OF ART
Box 1013, Toledo, Ohio 43697

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Mr. Otto Wittmann, Director
Toledo Museum of Art
Box 1013
Toledo, OH 43697